NEEDS, POSSIBILITIES AND CONSTRAINTS TO DEVELOP A 3D CADASTRAL REGISTRATION SYSTEM

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ABSTRACT

The Land Registration Office (Cadastre) is mandatory to register the legal status of real estate objects. To be capable to do this, those objects (parcels) are digitally stored and maintained in a spatial information system. Until now the spatial information system used by the Dutch Cadastre to register the legal status of land is a two dimensional system. The juridical boundaries defining a parcel are maintained two dimensionally.

Since there is a growing interest in using space below and above the surface, 3D information becomes increasingly important in registering today's world. In the Netherlands, a 2D system to register the legal status of real estate objects has appeared not to be sufficient anymore in all cases. Therefore, research is needed for a registration system, which is capable to take the juridical relevant information in the vertical dimension into account.

At the Delft University of Technology, Department of Geodesy, research is done in collaboration with the Netherlands' Kadaster to study the 3D issue of cadastral registration in the Netherlands in a fundamental way. During this research the needs, possibilities and constraints to develop a 3D cadastral registration system are examined. The potentiality to register property in all land spaces (including under and above the surface) will make adjustment of the current 'flat' legislation possible, which is based on a division of land in 2D parcels. It also could start a process of changes in the registration of properties and characteristics of the Kadaster, concerning the vertical dimension.

1. INTRODUCTION

The function of land registration is to provide a safe and certain foundation for the acquisition, enjoyment and disposal of rights in land. A cadastre is similar to a land register with the additional function to form a base for land taxation (*Larsson, 1991*). A cadastre is an information system consisting of two parts, a series of maps or plans showing the size and locations of all land parcels, together with text records, containing the legal status of the parcels (*Dale and McLaren, 1999*). The cadastre is responsible for maintaining the boundaries of the parcels and for registering the legal status of the parcels like the right of property and limited rights established on the parcels (*Snijders and Rank-Berenschot, 1994*).

The Netherlands' Kadaster (the Dutch Cadastre and Public Registers Agency) is responsible for the cadastral registration in the Netherlands. In order to increase the efficiency and to make network access possible to the data involved, the Netherlands' Kadaster uses a spatial

information system with a completely computerised cadastral map for maintaining the geometry and topology of parcels. The legal status of the parcels is maintained in a separate administrative database-system. A link between those two subsystems exists by the unique parcel number (*Lemmen et. al, 1998*).
Until now, the juridical boundaries used for registration are fixed in 2D space. The whole country is divided into parcels which are defined in the 'flat' 2D spatial information system. The parcels are the basis for the registrations done by the Kadaster. The vertical dimension of the legal status of real estate objects, which may be important, can only be registered administratively and can therefore not be registered adequately in many cases.

In areas with an intensive use of land, like the Netherlands, there is a growing interest in using space under and above the surface. To be able to define and manage the juridical situation satisfactory, 3D information becomes indispensable in registering today's world. According to the *Dutch Civil Code (1992)*, the right of property of a parcel is not limited in the vertical dimension and hence the property extends to the middle point of the earth and into the sky. This definition of property needs reconsideration when the use of space under and above the surface comes into play.
In the Netherlands more and more situations occur in which the vertical dimension is an important factor in registering the legal status of real estate objects. Since it is expected that the Netherlands' Kadaster will meet registration complications in the future, research is needed for a 3D cadastral registration system.
At the Delft University of Technology, Department of Geodesy, a research is carried out in collaboration with the Netherlands' Kadaster to study the 3D issue of cadastral registration in the Netherlands in a fundamental way. During this research the needs, possibilities and constraints to develop a 3D cadastral registration system are examined. The potentiality to register property in all land spaces (including under and above the surface) will make adjustment of the current 'flat' legislation possible, which is based on a division of land in 2D parcels.

The aim of the research is to develop a prototype of a Land Information System, which can take the juridical relevant spatial information in the vertical dimension into account. The research focuses on the situation of the cadastral situation in the Netherlands. However other countries with an intensive use of land encounter or will encounter the same problems as well.
This paper gives a description of the reason and the background of the research. In the second paragraph, a review is given of situations where it has appeared that a 2D cadastral registration system to depict the legal status of real estate objects is not sufficient anymore. Possible meanings of 3D concerning cadastral needs are given in the third paragraph. Paragraph 4 describes how the Netherlands' Kadaster presently deals with the situations mentioned in paragraph 2. Finally, some additional considerations for this research are given and the paper closes with conclusions.

2. REAL ESTATE OBJECTS UNDER AND ABOVE THE SURFACE

The 2D registration system used by the Netherlands' Kadaster is not fully capable of representing registration situations in which the third dimension is an important factor. Cadastral registration situations in which a 3D component have occurred to be important are the following:

- subterranean buildings and constructions (metrostations, subterranean parking places etc.)
- subterranean infrastructure (see figure 1)
- constructions on top of each other (see figure 2)
- apartments
- ownership and location of cables and pipes
- polluted areas
- resource permits

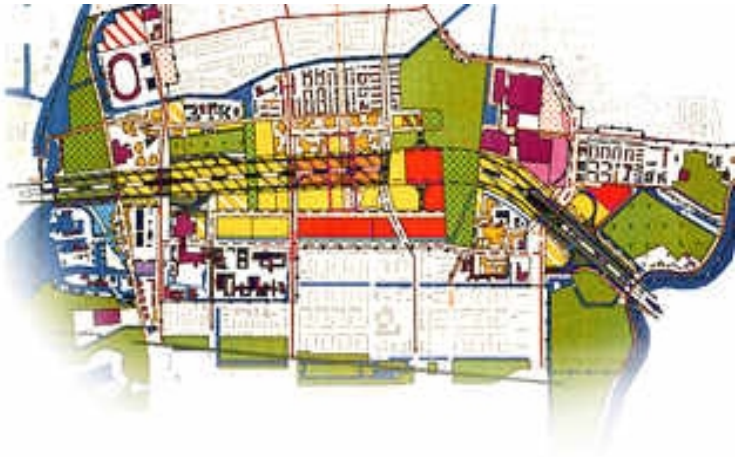

Figure 1: Subterranean infrastructure and constructions like metros demand a further going juridical partitioning of space than a 2D partitioning. This map contains a sketch of a tunnel (it is not a cadastral map).

Figure 2: A situation in which defining right of property in a 2D database is complex: a road, bridge and a building on top of each other, all with different owners.

All those situations have in common that the third dimension is relevant in bounding the legal status of the real estate objects. The legal status of those objects could be better maintained when the Kadaster would be able to deal with the third dimension of those objects.

The registrations at the Kadaster that encounter or will encounter the 3D issue can be distinguished in three activities:
- registrations according to Private Law
- registrations according to Administrative Law
- maintaining factual objects

Private Law
Regarding Private Law, the registration activities where 3D information might be relevant are (the Dutch terms are added in italic, between braces):
- right of property (*eigendomsrecht*)
- limited property rights (*beperkte rechten*):
  - right of building i.e. the right to erect buildings under, on or above land owned by a third party (*opstalrecht*)
  - long lease (*erfpacht*)
  - easement (*erfdienstbaarheid*)
- right to an apartment or condominium right (*appartementsrecht*)
- joint ownership (*mandeligheid*)

Administrative Law
Registrations of restrictions dictated by Administrative Law (*Publiekrechtelijke Beperkingen*) with a potential 3D component, are:
- obligation to the owner of land to tolerate construction for public good, like lampposts, electrician cables, water pipes, telecom pipes (*Belemmeringenwet Privaatrecht*)
- deprival of minerals in the ground of the landowner (*Mijnwet*)
- registrations in order to protect historical monuments (*Monumenentwet*)

- registration of severe soil pollution (*Wet Bodembescherming*)

In all those cases, the parcels are affected with a restriction in the right of property. Those restrictions are registered, not the factual objects, which cause the restriction (cable, pipe etc.).

Factual situations

Apart from registrations dictated by Private Law and Administrative Law, factual situations sometimes demand a 3D approach. These concern objects that do not need to be registered themselves, but that are or will be maintained by the Kadaster, since they have a relation to registration activities. These concern the following objects:

- subterranean constructions
- subterranean infrastructure (tunnels, metro's)
- soil pollution
- cables and pipes

Those objects are not registered by the Kadaster as such, since they do not need to be registered themselves. However, knowledge about the location, geometry and extent of those objects can be very relevant for registrations done by the Kadaster and in other maintaining activities done by others than the Kadaster. The representation and definition of those objects can therefore be useful for future activities.

3. THE MEANING OF 3D

Geo-data can be represented in two clearly distinct Euclidean dimensional contexts:

- 2-D: a spatial object or region which is defined in 2-D space by measurements on axes x,y
- 3-D: a spatial object or domain extending through 3-D space defined by axes x,y,z

(*Raper and Kelk, 1991*).

According to the dictionary 3-dimensional means: having, or appearing to have, three dimensions (length, breadth and depth). In the geo-scientific sense fully 3D means, that every point in space can be approached by means of a x-, y-, z-co-ordinate. When the z value is stored as an attribute of a 2 dimensional point, line or polygon it is called to be 2.5D or 2D+1D. With this, only a single z value can be stored for each x,y location and thus the surface can not be overfolded (*Raper and Kelk, 1991*).

Looking at the registration of area characteristics of real estate objects (parcels) by the Kadaster, the question occurs whether the actual area should be registered instead of the projected area. This latter one is currently registered.

In the Netherlands a 2.5D surface is available for the whole country (Actual Height model of the Netherlands (AHN)), which has a density of at least one point per 16 square meters. This 2.5D surface has been obtained by the use of airborne laser altimetry (*Van Heerd et al., 2000*). In the future, this information could be very useful in cadastral registrations to consider the vertical dimension.

The growing need for maintaining vertical information by the Kadaster is evident. A complete 3D spatial information system seems to be the solution for the problems met by the Kadaster. However, this might be too much detail for the purpose that it has to serve. Besides one should not only consider the development of such a system but also the availability of the needed 3D data to make the system operational. Also incorporating the system into the present system, into the working processes and into the present legislation is an important factor for contemplation.

In order to develop a useful 3D registration system it is very important to examine the real needs of the Kadaster: what information is actually needed to perform the cadastral tasks. To answer this question not only the present situation should be considered, but also possible

adjustments of legislation and possible changes in the registration of properties. Whether and to what extent the Kadaster needs a full 3D spatial information system should be subject of research.
Depending on the registration situation, it must be examined which of the following registration possibilities is required:
- 2D, without any vertical information
- the use of 'under' or 'above' labels, without metric
- 2.5D
- a multi-layer approach of two or more 2.5D layers
- complete 3D

The optimal solution per region may differ but a good connection between the different kinds of vertical (and horizontal) information is essential.
In conclusion, the meaning of the expression 3D in the sense of developing a 3D registration system for the Kadaster depends on the actual requirements of the Kadaster (now and in the future) and should be subject of research.

4. CURRENT REGISTRATION OF 3D SITUATIONS

Common to all situations mentioned in the second paragraph is the importance of considering the 3D characteristics of real estate objects when registering the legal status of those objects.
The occurrence of such registration situations has forced the Netherlands' Kadaster to look for ad hoc solutions within the current registration possibilities.
The solutions have in common that they are administrative solutions, reducing the 3D situations to the partitioning of the country into 2D parcels. The current cadastral registration is based on the property relations in a column: the 2D parcel on the surface is the entrance for registration activities. A horizontal division in (the legal status of) property is made by establishing rights and limited rights on the parcel.
In the case of a construction above or under the surface, the legal status of the construction is defined within today's registration possibilities. The object itself can not be defined as a cadastral object in the cadastral map and used as a base for registration. Instead, the 2D parcels on the surface are used as the entrance to register the construction, by registering rights and limited rights on the parcels. This means that constructions are unnaturally divided into parts that match with the parcels partitioning the surface (see figure 3).

Figure 3: Illustration of how property relations in the vertical dimension are registered based on 2D parcels. This figure represents the cadastral situation of the photo of figure 2.
The arrow indicates the position of the camera. The building is divided into three parts to be able to register the legal status of the building. The firm 'Nationale Nederlanden' possesses the whole building. The rights and restrictions of the concerning parcels are as follows: Municipality possesses a restricted property on parcels 1719 and 1720. 'Nationale Nederlanden' possesses an unrestricted property on parcel 1718, a right of building on parcel 1719 and a right of long lease on parcel 1720.

Insight in the 3D situation can be given by the addition of a (analogue) drawing to the concerning deed, which is obligatory in some situations. The administrative database gives access to the drawings by a link to the location of this deed.
The possibility to represent 3D characteristics of properties, could support a better definition and registration of the legal status of real estate objects in the vertical dimension.

The methods currently in use at the Netherlands' Kadaster to register situations with a vertical component and their shortcomings will be further described in the following.

4.1 Registrations according to Private Law

The most included right that a person can have is the complete right of property (*volle eigendomsrecht*). The right of property of a parcel contains a 3D component, since the property should be defined in the vertical dimension, when the vertical dimension of this right comes into play. Concerning this, according to the *Dutch Civil Code (1992)* the right of property contains:

- the overground
- the earthlayers beneath it
- buildings and constructions which are permanently fixed to the ground (directly or by means of other constructions)

The competence to use the owned land includes the use of space above and under the surface of the owned parcel. The use of space above and under the surface is permitted to third persons, as long as this is done as high or as low, that there is no sense for the owner to object against this use. This quotation from the Civil Code indicates the vagueness of the way the right of property is defined in the vertical dimension.

Registration the legal status of constructions under or above the surface

Constructions under or above the surface are permanently fixed to the surface. Therefore, the owner of the construction can be found via the owner of the above lying parcel, if no other rights or restrictions have been established on the parcel (*verticale natrekking*) (*RAVI, 2000*).
In most cases, the owner of the construction under the surface is not the same as the owner of the land parcel. The Kadaster possesses a few juridical instruments to register the legal status of those situations.
The Kadaster is able to register the legal status of objects under or above the surface by registering a 'right of building' to others than the owner (*opstalrecht*) on the surface parcel. This right is a restriction to the right of property to the owner of the parcel. 'Right of building' is a right to erect buildings on, above or under land owned by a third party. This right can therefore be used when the owner of the construction is not the same as the owner of the parcel. By means of this right, a horizontal division in property takes place (*De Jong, 1995*). The right itself is registered, as well as the person who possesses this right (the 'third' party). However whether it concerns a building on, above or under the surface is not registered. The registration provides the possibility to dictate restrictions in the right of use to the owner of the land on which the right of building is established in order to avoid damage to the construction (*Van der Molen, 1998*).
To specify a subterranean construction the code 'OB' (*Ondergronds Bouwwerk*) can be added in the registration, as well as a link to a drawing to illustrate the factual situation. This drawing is not obliged. With this, the cadastral registration offers the possibility to indicate at least that there is a subterranean construction (*Ravi, 2000*).
Although a drawing of the property situation is not obliged, the Kadaster emphasises the necessity to store drawings when deeds are drawn up in those situations and encourages notaries to do this since 1999 (*Klaasse, 1998*).
The inadequacy met in the above solutions is that the right itself is administrated but not the geometry or location or even the function of the object (underground infrastructure, metrostation, subterranean parking place etc.). Another disadvantage is that large constructions are divided into parts that match the above lying parcels, instead of considering them as objects themselves.
When the legal status of property under or above the surface is not registered explicitly, the legal status can be obtained by 'the horizontal accession to real estate' (*horizontale natrekking*) (*De Jong, 1998*). According to the *Dutch Civil Code (1992)*, the owner of a real estate is also the owner of the components of the real estate. When the property situation is not clear, the owner of a component (like a tunnel) can be found by finding the point, and thus the parcel, where it is fixed to the surface. With this, a factual horizontal division in property takes place (see figure 4). The disadvantage of this method is that the right itself is not explicitly registered, neither is the object of the right.

The horizontal accession to real estate might conflict with the definition of the right of property, for example in the case of cables, pipes and tunnels. After all, according to the Civil Code the right of property contains all constructions that are permanently fixed to the parcel (*verticale natrekking*) (*Van Velten, 1997*).

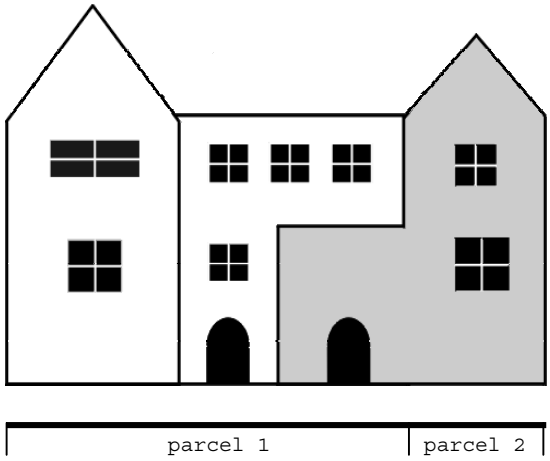

Figure 4: an illustration of 'the horizontal accession to real estate'.
The part of the grey house that stands on parcel 1 belongs to the owner of parcel 2 since this part is a component of the building on parcel 2.

Another instrument for the Kadaster to register the property of subterranean buildings is to use the right to an apartment (see further). Though this way of registration offers the best possibilities to register different owners in the vertical dimension, it is not the optimal solution, since this right was not actually founded for those situations. Moreover, the registration of the right to an apartment also encounters complications, as will be seen in the following.

Registration of the right to an apartment

Right to an apartment (*appartementsrecht*) is a right existing of:

- a share in an apartment building (this may be a group of buildings) and in the underlying ground
- a competence to the exclusive use of a certain part of this building (*exclusief gebruiksrecht*)

(*Snijders and Rank-Berenschot, 1994*).

The parts are called 'apartments' and the division in parts is based on a deed of division (*akte van splitsing*). A drawing is obliged in the deed in which the apartment building is divided into individual apartments. This drawing should give a clear picture of the cadastral situation by giving a cadastral overview of every floor.

Disadvantage of this registration is that only the groundparcel(s) of the apartment building is maintained on the cadastral map in the spatial information system and therefore the individual apartment parcels can not be recognised on the juridical cadastral map. This would be difficult, since those parcels are situated on top of each other and the juridical map of the Kadaster is 2D.

Another complication is that a person does not legally own one apartment, which makes this situation different from other ownership situations. A last disadvantage that can be mentioned is that an analogue drawing is always needed to clarify the cadastral situation while digital information becomes increasingly standard.

4.2 Registrations according to Administrative Law

The location of cables and pipes

According to Administrative Law (*Belemmeringenwet Privaatrecht*) the owner of land can be obliged to tolerate construction for public good like lampposts, electrician cables, water pipes, telecom pipes etc. (*Snijders and Rank-Berenschot, 1994*). The Kadaster registers the establishment of this restriction in property on a parcel. The restriction is stored in the administrative database. With this, only the parcel is known under which a cable or pipe is situated and not the exact (horizontal and vertical) location of the cable or pipe.

The obligation of toleration does not cause a horizontal division in property. Consequently, if there is no question of horizontal accession to real estate, the owner of the parcel becomes owner of the subterranean construction, and can therefore be held responsible for damage (*RAVI, 2000*).

The administrative registration of the locations of cables and pipes offers a few problems and limitations. When the parcel is subdivided, it is not known in which part of the parcel the cable or pipe is situated. Therefore, the database becomes polluted when the parcel is subdivided, since in that case all child parcels are charged with a restriction due to the (potential) presence of a cable or pipe. Those registrations are less accurate in comparison to the real situations. Furthermore, to manage the use of space below the surface it is important to register 3D information on cables and pipes. For example, knowledge about the location of cables and pipes can avoid damage during digging activities (see figure 5). In addition, by means of 3D information, a more exact limitation could be laid on the owners of the land to do anything that could damage the cables or pipes.

Figure 5: To avoid damage to cables, first digging by hand is necessary (De Volkskrant, (Dutch Newspaper), 6 Juli, 2000).

Another reason why it is desirable to define the exact location of cables and pipes is that owners of cables and pipes are obliged to pay the owners of the above lying parcels to use those parcels. By knowing the exact locations, the persons involved can be more accurately determined.
Finally, as was seen with subterranean constructions, the cables and pipes are divided into parts that match the above lying parcels, instead of considering them as one object themselves. With this, the attributes of the cables and pipes (owner, date of deed etc.) are stored with every above lying parcel. Besides the redundancy of information, this is a potential source for inconsistency of the database.

Registrations according to the Law on Soil Protection
According to the Law on Soil Protection (*Wet Bodembescherming*), severe soil pollution has to be registered by the Kadaster. The pollution is registered in the administrative database of the Kadaster by establishing the decision on a parcel. The four big cities of the Netherlands (Rotterdam, Amsterdam, The Hague, Utrecht) and the provinces are obliged to report such pollutions to the Kadaster. With this report, a (2D, analogue) drawing is obliged. However since the accuracy of those drawings is not prescribed, the exact locations of the pollution is still very unclear in most cases. Besides, 3D information on those locations is totally lacking. The drawings are maintained in a paper archive by the Kadaster.
The disadvantage of this registration is that, with the lack of an exact drawing, the whole parcel becomes affected by the decision. The exact location (in the horizontal direction as well as in the vertical direction) of the pollution is not registered. However, the 3D location of soil pollution would give more insight into the actual situation and would give better facilities to manage soil pollution. Another disadvantage that was already mentioned with the registration of the right of an apartment is that a digital representation of the situation instead of an analogue drawing would offer better registration possibilities. Furthermore, digital information makes public access to the information possible via the internet, which is desirable in today's society.

4.3 Factual situations

The cadastral registration (the administrative database) and the cadastral map barely contain any information about the actual existence, the legal status and the function of constructions under and above the surface. Although the cadastral map does contain the contours of constructions above the surface, the contours of subterranean construction are till recently not maintained on the cadastral map (*Klaasse, 1998*). The restrictions that are established on parcels can neither be found on the cadastral map, although those restrictions would give insight in the situation of the underground regarding the present registration procedures. The Kadaster has developed a digital tool, which enables visualising rights and restrictions on parcels by a link between the administrative database and the digital cadastral map (*Van Oosterom, 2000*). Until now, this querytool works on a half-year copy of the database and is therefore not reliable in all cases.
The current policy of the Kadaster is to reflect subterranean constructions on the cadastral map by means of a stripe-line (*RAVI, 2000*). The possibility to add the code 'OB' (*Ondergrondsbouwwerk*) with the registration of a right of building is helpful since it indicates that this concerns a construction under the surface.
At the moment, there are no formal rules for registering the legal status, the (2D or 3D) geographical location and the extent of real estate objects, which do not have to be registered as such. Since the actual objects can be important in cadastral situations and other maintaining

activities, caution is required to see the world not only in 2D parcels but also look at the objects under and above the surface as a whole. This could lead to a change in the registration of properties and in the definition of characteristics of the Kadaster in the future.

5. CONSIDERATIONS FOR MAINTAINING THE 3D JURIDICAL WORLD

The fundamental problem of the situations mentioned in paragraph 2 is how to register the 3D characteristics of those objects. In the ideal case, the juridical boundaries of real estate objects and parcels are maintained fully three dimensionally, in which every point of a boundary of a registered object is defined by a x-, y- and z-co-ordinate. This would support legal security by supplying the possibility to register, to manage and to query the legal status of real estate objects in a 3D way.
As was seen in paragraph 3, a less detailed system might be more appropriate and more realistic to fulfil the needs of the Kadaster. This will be subject of further research.
The current solutions to 3D situations of the Netherlands' Kadaster described in paragraph 4 operate reasonable, although these are incidental, specific solutions. The risk of not being capable of executing the formal tasks adequately becomes higher, as the amount of (different) situations will grow for which the existing 2D system is not basically qualified. Furthermore, regarding the 3D component of the legal status of real estate objects would better reflect the situation in the real world.
It should be looked at to what extent a 3D system will offer improvements in order to complement the presently used 2D system.

From analogue drawings to digital 3D models
To clarify the legal status of situations with a 3D aspect (constructions under or above the surface, apartments) drawings are added to deeds. Since until now this is not a digital document, this method does not use the possibilities of today to increase efficiency and standardisation. Moreover since a digital link between the objects in the drawings and objects in the (administrative) information system is lacking, the legal security is not optimally preserved. Therefore, this research looks for a digital solution to represent the 2D and 3D information of objects. Digital CAD drawings can be used, but they have to be converted from a local co-ordinate-system to the co-ordinate system of the 'real' world, that is used to represent and to maintain the cadastral map.

Integration of (3D) CAD en GIS
Most commercially available Geographical Information Systems (GIS) are only designed to handle 2-D spatial data. Some systems contain limited 3D functionalities for surface modelling or for visualisations by assigning an attribute for z values (such as elevation) to a set of x,y locations. Here only the x,y locations are stored within the spatial indexing system and the z value is defined as an attribute (*Raper and Kelk, 1991*).
In computer aided design (CAD) fully 3D modelling is better established. While many 3-D modelling systems have been developed for high quality computer-aided design (CAD), these systems have limitations for geoscientific applications. These systems are primary developed for visualisations, which cannot by analysed or interrogated. Moreover, CAD systems have no or limited facilities for data-management: they are project-based instead of database-based and operate with local co-ordinate systems instead of one 'real-world' co-ordinate system (*Raper and Kelk, 1991*).

Increasingly, GIS software offers 3D realistic visualisations exploiting the CAD technology. Whether GIS really needs full 3D modelling is still a relevant and living question (*Rimscha, 1997*).
Nowadays a lot of research is done on the subject of linking 3D GIS en 3D CAD. The research to develop a 3D registration system for the Netherlands' Kadaster will join the findings in this research area.

OpenGIS solutions
Within the context of OpenGIS, research is done on the developments of standards for 3D data structures and 3D data models and on the development of standards for cadastral systems (*OGC, 1998*). The membership of our department of the OpenGIS Consortium (OGC) makes it possible to join the findings of the OGC and to have a significant influence on the development of standards. The active participation in Special Interest Groups (SIG's) assures to use the newly developed technologies and standards within OpenGIS, which are world-widely accepted. A SIG on Cadastres is currently founded.
Joining the OGC standards also implies joining the ISO standards since ISO standards and OGC standards are being harmonised and accepted and certified by both.

3D information and other disciplines
To ensure the legal security in general the 3D character of situations should get more attention when the 3D environment comes into play. These characteristics should therefore also be encountered in zoning plans and regional plans. The construction of 3D visualisations of planned infrastructure and buildings enables obtaining more insight into the vertical planning of the region (*De Jong, 1998*). Nowadays virtual reality techniques can be used to visualise (3D) geo-data. At our department, a 3D GIS-Virtual Reality system has been developed, with which it is possible to create a 3D-visualisation based on a GIS-database (*Verbree et al., 1999*).
Maintaining 3D information also enables one to deal with the 3D characteristics of objects. Examples are calculating the contents of buildings (important knowledge for imposing taxes), dictating a maximum construction height and depth and obtaining information for spatial modelling like the modelling of noise levels.
For those reasons, a 3D cadastral registration system should be closely connected to other disciplines that are looking for the need, the availability and the possibilities of 3D geo-information.

6. CONCLUSIONS

Since there is a growing interest in using space under the surface, the Kadaster is forced to register situations with a vertical dimension. Until now a horizontal division in property can only be registered administratively by establishing rights and limited rights on a (2D) parcel.
To assure proper registrations of the legal status of real estate objects in the future, situation with a vertical component should be approached fundamentally by looking at the underlying 3D issue.
Therefore, a research is carried out to study the needs, possibilities and constraints of developing a 3D cadastral registration system in order to increase legal security. The research focuses on developing a system to support registering the legal status of the space under and above the surface. This will make adjustment of the current 'flat' legislation possible and it could start a process of changes in the registration of properties and characteristics of the Kadaster, concerning the vertical dimension.

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